

IN THE CLAIMS

This listing of the claim will replace all prior versions and listings of claim in the present application.

Listing of Claims

1. (currently amended) A storage system comprising:

a disk system, having at least one disk to store data, including a disk control unit to control writing and reading of data to and from said at least one disk, and a disk cache for transmitting and receiving data to and from said at least one disk;

a file server, connected to said disk system, including a CPU, a main memory to store programs and data for said CPU, and a network interface to be coupled to clients through a network; and

interfaces for sending and receiving data to and from other storage systems through a communication link;

wherein said main memory includes a file system-processing unit managing storage areas of said at least one disk, so that files are correlated with data locations on said at least one disk, and a file-system cache to be used by said file system-processing unit;

wherein said disk control unit receives data of a file that has been updated in another storage system and a history of file-management information from another disk system through said communication link, without using another file server which is connected to said another disk system of said another storage system, and stores the received data of a file and the history of file-management information on the disk cache of the disk system of said storage system;

wherein said file server ~~refers to~~monitors the history of the file-management information on the disk cache of the disk system of said storage system and updates file-management information in said file-system cache of said main memory of said storage system in accordance with the update of the file performed in said another storage system if a change in the history of the file management information on the disk cache of the disk system of said storage system has occurred.

2. (previously presented) A storage system comprising:

at least one disk to store data;

a disk control unit to control writing and reading of data to and from said at least one disk;

a disk cache for transmitting and receiving data to and from said at least one disk;

a file server including a CPU, a main memory to store programs and data for said CPU, and a network interface to be coupled to clients through a network; and

interfaces for sending and receiving data to and from other storage systems through a communication link;

wherein said main memory includes a file system-processing unit managing storage areas of said at least one disk, so that files are correlated with data locations on said at least one disk, and a file-system cache to be used by said file system-processing unit;

wherein said disk control unit receives data of a file that has been updated in another storage system and a history of file-management

information through said communication link and stores the received data of a file and the history of file-management information on the disk;

wherein said disk control unit refers to the history of the file-management information on the disk and updates file-management information in said file-system cache in accordance with the update of the file performed in said other storage system; and

wherein, when said disk control unit receives a read request from a client coupled to the storage system, said disk control unit refers to the file-management information updated in said file-system cache and transfers the contents of the updated file to said client according to the file-management information,

wherein said file system-processing unit comprises a metadata-update monitor monitoring the update of metadata, including data for file management, by referring to a journal log, including a history of said management information, and a metadata-updating unit updating the metadata in said file-system cache when said metadata-update monitor detects the update of a file.

3. (original) The storage system of claim 2, wherein said file system-processing unit comprises, in addition to said metadata-update monitor and said metadata-updating unit, a file system-cache purger discarding the corresponding user data in said file-system cache when the metadata is updated by said metadata-updating unit.

4. (previously presented) The storage system of claim 2, wherein said metadata-update monitor detects the update of the file by monitoring the writing of data into a journal-log area on said disk.

5. (previously presented) The storage system of claim 3, wherein said metadata-updating unit updates metadata temporarily stored in said file-system cache by monitoring the contents of the journal log on said disk, and wherein said file system-cache purger discards said user data in said file system-cache by detecting that the user data, including the contents of the file temporarily stored in said file system cache, is updated on said disk corresponding to the update of said metadata.

6. (currently amended) A file-reference method of a storage system, wherein said storage system comprises:

at least one disk;

a disk control unit to control writing and reading of data to and from said at least one disk;

a disk cache for transmitting and receiving data to and from said at least one disk;

a CPU;

a main memory to store programs and data for said CPU;

a network interface to be coupled to clients through a network; and

interfaces for sending and receiving data to and from other storage systems through a communication link;

wherein said main memory includes a file system-processing unit managing areas of said at least one disk, so that files are correlated with locations of on said at least one disk, and a file-system cache to be used by said file system-processing unit, said file-system-processing unit and said file-system cache forming part of a file server which is connected to said at least one disk;

said file-reference method comprising:

(a) a storing step in which said disk-control unit receives contents of a file that has been updated in another storage system and a history of file-management information through said communication link from said other storage system, without using another file server which is included in said another storage system, and stores the contents of a file and the history of file-management information on said disk cache of said storage system a disk;

(b) a monitoring step in which said file system-processing unit ~~refers~~ monitors ~~to~~ the history of the file-management information stored in said disk cache of said storage system;

(c) an updating step in which, based on monitoring ~~a reference to~~ the history of the file-management information, said file system-processing unit updates the file-management information in said file-system cache in accordance with the update of the file in said ~~other~~ another storage system if a change in the history of the file management information on the disk cache of the disk system of said storage system has occurred; and

(d) a transfer step in which, when said disk-control unit receives a read request from a client coupled to the storage system, the storage system

refers to the file-management information updated in said file-system cache and reads, from the disk, the contents of the updated file and transfers the contents to said client.

7. (previously presented) A file-reference method of a storage system, wherein said storage system comprises:

at least one disk;

a disk control unit to control writing and reading of data to and from said at least one disk;

a disk cache for transmitting and receiving data to and from said at least one disk;

a CPU;

a main memory to store programs and data for said CPU;

a network interface to be coupled to clients through a network; and

interfaces for sending and receiving data to and from other storage systems through a communication link;

wherein said main memory includes a file system-processing unit managing areas of said at least one disk, so that files are correlated with locations of on said at least one disk, and a file-system cache to be used by said file system-processing unit;

said file-reference method comprising:

(a) a storing step in which said disk-control unit receives contents of a file that has been updated in another storage system and a history of file-management information through said communication link from said other

storage system and stores the contents of a file and the history of file-management information on a disk;

(b) a monitoring step in which said file system-processing unit refers to the history of the file-management information stored in said disk;

(c) an updating step in which, based on a reference to the history of the file-management information, said file system-processing unit updates the file-management information in said file-system cache in accordance with the update of the file in said other storage system; and

(d) a transfer step in which, when said disk-control unit receives a read request from a client coupled to the storage system, the storage system refers to the file-management information updated in said file-system cache and reads, from the disk, the contents of the updated file and transfers the contents to said client,

wherein said monitoring step includes a metadata-update monitoring step of monitoring the update of metadata, including data for file management, by referring to a journal log, including a history of said management information, and

wherein said updating step includes a metadata-updating step of detecting the update of the file by said metadata-update monitoring step and updating the metadata in said file-system cache.

8. (previously presented) The file-reference method of claim 7, further comprising a file system-cache purging step of discarding user data corresponding to the updated metadata in said file-system cache when the metadata is updated in said metadata-updating step.

9. (previously presented) The file-reference method of claim 7, wherein said metadata-update monitoring step includes a step of detecting the update of a file by monitoring the writing of data into a journal-log area on said disk.

10. (previously presented) The file-reference method of claim 8, wherein said metadata-updating step includes a step of updating metadata temporarily stored in said file-system cache by monitoring the contents of the journal log on said disk, and

wherein said file-system cache purging step includes a step of detecting that the user data, including the contents of the file temporarily stored in said file-system cache, has been updated on said disk corresponding to the update of said metadata and discarding said user data in said file-system cache.

11. (currently amended) A network system comprising:
a first storage system_i and
a second storage system_i
wherein each of which said first and second storage systems
comprises:

a disk_i;
a disk-control unit to control writing and reading of data to and from said disk_i and;
a disk cache for transmitting and receiving data to and from said disk;

a file server including a CPU, a main memory to store programs and data for said CPU, and a network interface to be coupled to clients through a network; and

interfaces for sending and receiving data to and from disks of other storage systems through a communication link;

wherein each main memory of the first and second storage systems includes a file system-processing unit managing storage areas of a disk so that files are correlated with locations on the disk and a file-system cache to be used by said file system-processing unit;

wherein the disk-control unit of said first storage system receives contents of a file updated in the second storage system and a history of file-management information from the second storage system through said communication link₁ without using the file server of said second storage system that is connected to the disk of said second storage system₁ and stores the contents of a file and the history of file-management information on the disk ~~in~~ cache of said first storage system;

wherein the file system-processing unit of said first storage system monitors ~~refers to~~ the history of the file-management information on the disk cache of the first storage system and updates the file-management information in the ~~file-system~~ file-system cache of said first storage system in accordance with the update of the file in said second storage system if a change in the history of the file-management information on the disk cache of the first storage system has occurred; and

wherein, when said first storage system receives a read request from a client, said first storage system refers to the file-management information

updated in said file-system cache, reads, from the disk, the contents of the update file received from said second storage system, and transfers the contents to said client.

12. (previously presented) The network system of claim 11, wherein the file system-processing unit of said first storage system comprises:

a metadata-update monitor monitoring the update of metadata, including data for file management, by referring to a journal log, including a history of said management information; and

a metadata-updating unit updating the metadata in said file-system cache when said metadata-update monitor detects the update of the file.

13. (original) The network system of claim 12, wherein the file system-processing unit of said first storage system comprises, in addition to said metadata-update monitor and said metadata-updating unit, a file system-cache purger discarding user data in said file-system cache corresponding to the metadata when the metadata is updated by said metadata-updating unit.

14. (original) The network system of claim 12, wherein the metadata-update monitor of said first storage system detects the update of the file by monitoring writing of data into a journal-log area on the disk.

15. (previously presented) The network system of claim 13,

wherein the metadata-updating unit of said first storage system updates metadata temporarily stored in said file-system cache by monitoring the contents of the journal log on said disk, and

wherein, in accordance with the update of said metadata, the file system-cache purger of said first storage system detects that the user data, including the contents of a file temporarily stored in said file-system cache, has been updated on said disk and discards said user data in said file-system cache.

16. (previously presented) A storage system according to claim 1, wherein, when said disk control unit receives a read request from a client coupled to the storage system, said disk control unit refers to the file-management information updated in said file-system cache and transfers the contents of the updated file to said client according to the file-management information.